REMARKS

After the foregoing amendment, claims 1-19 and 21-23 are currently pending in this application. Claim 22 has been withdrawn from consideration as being directed to a non-elected species of invention. By way of this Reply, claim 20 has been cancelled, without prejudice, claims 2-19 have been amended to recite proper antecedent basis, and independent claims 1, 21, and 23 have been amended to more clearly recite the claimed the subject matter which the Applicants regard as the invention. The Title of the application has been amended to state "Resonant Scanning Probe Microscope." In the Drawings, Fig. 2 has been amended, and Figures 4 and 5 have been added. Pages 7 and 12 of the specification, with respect to the published international application, have been amended to identify newly added Figures 4 and 5. Applicants submit that no new matter has been introduced into the application by these amendments.

Objections to the Drawings

The Drawings continue to be objected to for failure to illustrate the following claimed elements: the scan lines (claims 1, 21, 23), the circular arrangement of scan lines (claim 19), the rectangular scan area (claims 17, 18), and monitoring a charge distribution in a semiconductor device (claim 20).

In accordance with the Examiner's remarks, Figure 2 has been amended as set forth in the enclosed Replacement Sheet to illustrate the "scan lines" of the present invention. New Figures 4 and 5 have been added to illustrate a rectangular

scan area and a circular arrangement of scan lines, respectively, in accordance with the present invention. Support in the Specification for new Figure 4 can be found at pg. 4, lines 2-11, of the published international application, and claims 17 and 18. Support in the Specification for new Figure 5 can be found at pg. 4, lines 2-11, and pg. 12, lines 16-28, of the published international application and claim 19. Furthermore, because claim 20 has been cancelled from this application, Applicants respectfully submit that the drawing objection for failure to illustrate monitoring a charge distribution in a semiconductor device should be withdrawn.

Applicants submit that no new matter has been introduced into the application by these amendments, and withdrawal of the Drawing objections is respectfully requested.

Objections to the Specification

The Examiner objected to the Title of this application as being non-descriptive. The Title has been amended to "Resonant Scanning Probe Microscope" and is believed to overcome the Examiner's objection. Withdrawal of the objection to the Title is respectfully requested.

Double Patenting Rejection

Claims 1, 21, and 23 are provisionally rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1, 26, and 38 of U.S. Patent Application No. 10/635,203. Because this is a provisional obviousness-type double patenting rejection, and the claims of this application are

currently under substantive rejection, Applicants have not included a Terminal Disclaimer at this time. However, Applicants will file the required disclaimer at such time that the claims of this application are in condition for allowance, if necessary to overcome this rejection.

Claim Rejections – 35 U.S.C. § 102(e) and 35 U.S.C. § 103(a)

Claim 23 continues to be rejected under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent No. 6,752,008 (Kley). Claims 1-4 and 6-21 continue to be rejected under 35 U.S.C. § 103(a) as being unpatentable over Kley in view of U.S. Patent No. 6,008,489 (Elings et al.). Claim 5 continues to be rejected under 35 U.S.C. § 103(a) as being unpatentable over Kley in view of Elings and further in view of U.S. Patent No. 6,614,227 (Ookubo). Applicants respectfully traverse these rejections for the reasons set forth below.

Independent claims 1, 21, and 23 of the present invention, as amended, all require lateral oscillation of either the probe (20, 54) or the sample (12) "at or near its resonant frequency such that oscillation amplitude directly determines scan line length" in order to effect a scan of the sample. In response to Applicants' argument that none of the cited prior art references, alone or in combination, either teach or suggest the use of a mechanical resonance to provide relative scanning motion between the sample and the probe as recited in the present invention, the Examiner states, "... the prior art does mention a resonant point (see col. 3, lines 45-50), that is, oscillating at resonance. Thus as understood, the probe is oscillated at 'near' its

resonance frequency. Still further, it is notoriously well known that all of the scanning probe microscopes operate at or near resonant frequency." December 21, 2005 Office Action at pgs. 7-8.

Based on the foregoing, Applicants' respectfully submit that the Examiner appears to be confusing an oscillation mode that is commonly known in the prior art, and as described by the primary references cited by the Examiner (*i.e.* Kley), with the entirely different oscillation mode of the present invention. As discussed in detail below, the critical difference between the prior art resonant oscillations and those of the present invention is that the prior art requires single pixel images to be respectively collected over multiple (resonant) oscillations, whereas the present invention requires a single (resonant) oscillation to sweep across multiple pixels.

The extract from Kley relied on by the Examiner as teaching "oscillating at resonance" (Kley at col. 3, lines 45-50), refers to a cantilever resonance point. This disclosure in Kley is concerned with the operation of an atomic force microscope (AFM), which is a particular type of scanning probe microscope (as stated in Kley). The AFM is based on the principle of mechanically scanning a nanometric probe over a sample surface in order to acquire an "interaction map" of the sample. As stated in the background section of the present invention (pg. 1, line 19 – pg. 2, line 6), the interaction force in the case of the AFM is simply the molecular interaction between the sample and the tip of a sharp probe attached to a cantilever spring. When the probe tip is brought into close proximity with the sample, the cantilever

bends in response to the interaction force. *See also* Kley at col. 2, lines 18-24. Images are collected by scanning the sample relative to the probe and measuring, for example, the deflection of the cantilever as a function of lateral position.

An AFM may be operated in a number of modes (*see* pg. 1, line 19 – pg. 2, line 6 of the published international application of the present invention). Of particular relevance to the operation of an oscillating probe is the dynamic imaging or "tapping" mode. This mode of operation is described in both Kley at column 2, line 32 and in the present application at pg. 18, lines 3-19. When performing dynamic imaging, an actuator drives the cantilever in a tapping motion. That is, the cantilever is oscillated <u>in a vertical direction</u> such that it is only in contact with the surface of the sample for a very small fraction of its oscillation period. This shortened contact time means that lateral forces on the sample are reduced and the probe is less destructive of the specimen as the scan is taken.

Another reason for oscillating the probe at resonance is to measure the oscillation amplitude, phase or frequency (the "cantilever resonance point", using the wording of Kley), which shift as the interatomic force varies. Each measurement of amplitude, phase or frequency therefore provides a quantitative measure of the image "intensity" (*i.e.*, strength of intermolecular forces between probe and sample) <u>averaged over the amplitude of each oscillation</u>. In order to reconstruct the image, the probe is placed over a particular point on the sample, oscillated at resonance and the "cantilever resonance point" measured for that

point, or pixel. The probe is then moved to a neighboring pixel and the oscillation is repeated. Oscillating the probe over different points on the sample enables reconstruction of the full image, permitting investigation of the nature of the interaction between the probe and sample. The amplitude/phase/frequency measurement may further be used to provide feedback in order to maintain the desired probe sample separation distance.

While these resonance point oscillations can, in theory, be in either a vertical or horizontal direction, there is a strong preference for vertical oscillation in order reduce noise in the resulting image. This is due to the fact that the resonance point is used to extract information about one pixel of the image at a time. Any horizontal oscillation would average the measurement over a larger area of the sample surface, and, if effect, result in blurring of the image.

With respect to the presently claimed invention, the Examiner asserts that, at least in relation to an AFM, "it is notoriously well known that most all of the scanning probe microscopes operate at or near resonant frequency." However, the mode of operation of prior art scanning microscopes such as Kley is distinguishable from the present invention. The prior art resonance is, as stated above, either due to <u>vertical oscillation</u> in order to bring the probe alternately towards and away from the sample surface, or <u>must be very localized in a horizontal direction</u>; that is, each oscillation must be maintained over a single image point. By way of contrast, the resonant oscillations of the present invention are <u>lateral oscillations</u> that scan the

probe across a non-localized area of the sample surface. That is, each oscillation encompasses multiple image points.

With reference to the AFM described by Kley, the scanning stage(s), whose purpose is comparable to that of the resonant oscillations of the present invention, are described at column 3, lines 11 - 31. This refers to X-Y and Z translation stages. Kley does not disclose or suggest that these stages are set to provide resonant oscillations. The translation stages in Kley are distinguishable from the resonance identified by the Examiner. As stated above, the resonance referred to in Kley describes the cantilever resonance point that "is shifted by the interatomic forces acting between the tip and the surface as the tip is scanned across the surface." Kley at col. 3, lines 45-51. Therefore, the resonance and scan are two separate features of the AFM described by Kley.

An AFM constructed in accordance with the present invention is described at pg. 15, line 3 - pg. 19, line 10 of the published international application, with reference to Figure 3. As can be seen, it is the X-Y scanning stage that is set to oscillate at (or near) resonance, with the resonance being fundamental to the scan. Further, a scanning probe microscope operated in accordance with the present invention, *i.e.*, with resonant lateral oscillations, can be of the type of that is operated in dynamic imaging mode which also includes resonant vertical oscillations (*see* pg. 5, lines 8-14 and pg. 18, lines 3-19), provided that either the probe or sample surface is laterally oscillated in order to provide a relative

oscillatory motion of the probe to carry out a substantially linear sweep across the sample surface (*see* pg. 5, line 27 – pg. 6, line 10).

In summary, the oscillations of the prior art, and Kley in particular, are carried out as part of the measuring process for obtaining a single image pixel or point, and, therefore, are more efficiently carried out as vertical oscillations. The oscillations of the present invention are distinguishable from the prior art oscillations because each oscillation laterally sweeps across the sample surface in order to gather information from multiple pixels or points on the sample surface. That is the oscillatory motion of the present invention is carried out across the sample surface and not localized to a single image pixel. Each scan line is directly provided by oscillating either the probe or the sample at or near resonance, as opposed to simply translating the probe, as in the X-Y and Z translation stages of Kley. Finally, oscillation amplitude in the present invention directly determines scan line length, whereas, in the prior art, oscillation amplitude, at most, determines resolution of a pixel at one point on the scan line.

The foregoing distinguishable features of the present invention over Kley are apparent from independent claim 1 as follows:

<u>Claim 1</u>

paragraph 3: "means (22, 52) for oscillating either the probe (20, 54) or the sample (12) in order to provide <u>relative non-localized oscillatory motion of the probe (20, 54) across the surface</u>;"

paragraph 6: "... wherein a scan area is covered by an arrangement of scan lines, <u>each scan line being provided by laterally oscillatinq</u> either the probe (20, 54) or the sample (1 2) <u>at or near its resonant frequency</u> such that <u>oscillation amplitude directly determines scan line length</u> ... ."

Similar features are recited at step (b) of independent claim 21 and paragraphs 3 and 5 of independent claim 23.

Because Kley does not disclose or suggest the resonant oscillatory motion of the present invention, Applicants' respectfully request withdrawal of the anticipation rejection of independent claim 23 over Kley.

Applicants' also respectfully request withdrawal of the obviousness rejections of claims 1-19 and 21 of the present invention. Kley is distinguishable from independent claims 1 and 21 for the reasons discussed above. As set forth in more detail in Applicant's November 18, 2005 Reply, neither Elings or Ookubo disclose a scanning probe microscope in which the scan is carried out by means of resonant oscillation as in the presently claimed invention, and, therefore, do not resolve the shortcomings of Kley.

<u>Conclusion</u>

If the Examiner believes that any additional minor formal matters need to be addressed in order to place this application in condition for allowance, or that a telephone interview will help to materially advance the prosecution of this

application, the Examiner is invited to contact the undersigned by telephone at the Examiner's convenience.

In view of the foregoing remarks, Applicants respectfully submit that the present application, including claims 1-19 and 21-23, is in condition for allowance and a notice to that effect is respectfully requested.

Respectfully submitted,

Miles et al.

By Ryan W. O'Donnell
Ryan W. O'Donnell
Registration No. 53,401

Volpe and Koenig, P.C.
United Plaza, Suite 1600
30 South 17th Street
Philadelphia, PA 19103
Telephone: (215) 568-6400
Facsimile: (215) 568-6499

RWO/vs
Enclosures

IN THE DRAWINGS

The enclosed sheets of drawings includes changes to Figure 2, and new Figures 4 and 5. The enclosed sheet, which includes Figure 2, replaces the originally filed sheet, which includes Figure 2, in order to more clearly illustrate the scan lines in accordance with the present invention. New Figures 4 and 5 have been added to illustrate a rectangular scan area and a circular arrangement of scan lines, respectively, in accordance with the present invention.